DESIGN AND FABRICATE ROCKET ENGINE

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:
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Position:DEPUTY DEAN
Date:25 NOVEMBER 2010

STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurently submitted for award of other degree.

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ABSTRACT

The objective of this project is to design and fabricate the Rocket Engine.This project describe the shape of Rocket that will fabricate follow the dimension that give by my supervisor.Actually there a several type of Rocket Engine.There are Rocket Engine based of thermal,water,hybrid,solid,and resistojet(electronic).So,the Rocket that will fabricate is from the solid type.One of the important thing a rocket is type of noozle,from the research in the internet De'Laval Noozle is the better type of noozle to use.Then material also another important thing in making Rocket.Material that will use must have good enough strenght to hold the explosion that will happen to move up the rocket.The better material is Stainless Steel it is light and have a good strenght,but cause of limited soucrce the material that use for make this Rocket is from mild steel.It is also have good strenght but it heavy than stainless steel.This project start from making the design and make it using Solid Work Software.Finish the design then the rocket can be made use a Lathe Machnine.Majority this rocket will be made by Lathe Machine.But from the start of fabricte the machine that involve also like bendsaw and drilling machine.Rocket engine that will be made have three part.First part is cap to close the hole on the upper body,a body and noozle.All this part will be assembly and were tied by bolt.It was susessfully done and able to function as needed.

ABSTRAK

Tujuan dari projek ini adalah untuk merancang dan membuat projek Rocket Engine. This projek menggambarkan bentuk Rocket yang akan dibuat mengikut ukuran yang diberikan oleh penyelia.Sebenarya ada pelbagai jenis Rocket Engine.Antaranya adalah Rocket Engine berasaskan therma,air, hibrid, motor, dan resistojet (elektronik). Jadi, roket yang akan dibuat adalah dari jenis solid atau motor.Salah satu perkara yang penting tentang membuat roket adalah jenis nozzle, daripada kajian di internet De'Laval Noozle adalah jenis yang lebih baik untuk digunakan.Selain itu bahan yg digunakan untuk membuat roket juga adlah penting.Bahan roket yang akan digunakan harus mempunyai kekuatan yang cukup baik untuk menahan ledakan yang akan terjadi untuk bergerak ke atas bahan rocket. Stainless Steel itu adalah ringan dan mempunyai kekuatan yang baik, tapi disebabkan sumber bahan yang terhad bahan yang digunakan untuk membuat roket ini adalah dari jenis mild steel.Ia ringan juga mempunyai kekuatan yang baik tetapi berat daripada stainless steel.Reka bentuk projeknya ini akan di lukis menggunakan Solid Work Software.Tamat sahaja mereka bentuk maka roket boleh dibuat menggunakan mesin larik.Keseluruhanya roket ini akan dibuat menggunakan mesin larik. Pembuatan roket tidak hanya bergantung dari mesin larik.Tetapi dari awal fabrikasi mesin yang melibatkan juga adalah ‘bendsaw’ dan fungsi gerudi mesin juga tidak ketinggalan turut digunakan.Rocket yang akan dibuat mempunyai tiga bahagian.Pertama adalah bahagian cap untuk menutup lubang pada tubuh bahagian atas, badan dan noozle.Semua bahagian ini akan diikat dengan bolt. Projek ini selesai dilakukan dan mampu berfungsi sebagai diperlukan.

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Ve	Veloxity Exit	(m/s²)
Ae	Area Exit	(m)
Pe	Pressure Exit	(pa)
M	Moment	(Nm)

CHAPTER 1

INTRODUCTION

1.1 PROJECT SYNOPSIS

The project including the design and fabricate of Rocket Design. The rocket that will fabricate is just a prototype it is not same as rocket that already have. In producing the design of rocket engine, there are including with the process of generating concept, design the concept and fabrication.The rocket engine that will build in two type first for the launching in the air and second for the testing.Both rocket will made from mild steel cause of limited source.Before this in the planning the rocket will build from stainless steel,it is because stainless steel more light and also have a good strength to hold exploded combustion that will happen in the rocket.But mild steel also have a good strength and a little bit heavy from the stainless steel.In the fabrication process rocket will be divided with three part.First part is cap then body and follow by the nozzle at the bottom.To making this part all of it will done by using lathe machine.Then for the assembly drilling process is needed to make a hole at the all of the part and follow by threading to make it easily to enter by bolt.For the test rocket it need trolley to make a testing .The trolley will fabricate using bending machine.It body from plate cause it more hard and can hold the high temperature of fire that out from noozle.

1.1 PROBLEMS STATEMENT

The problem statement is to find the suitable material as a Rocket engine body.The material have a good strength and light so the rocket can operate kindly.

1.2 PROJECT'S OBJECTIVE.

The objective for this project is: To design and fabricate a rocket engine

1.3 PROJECT'S SCOPE.

Two rocket engine will be design and fabricate every rocket have different function.First rocket for the launcher in the air and second for the testing.The rocket that will build is from the type of solid rocket.

1.4 THE PROJECT PLANNING.

Following to the Gantt chart, the project started with getting the problem statement, scope and the objective for the project. This process include with the getting the project title, first meeting with the supervisor, getting the information that regarding to this project through internet and the other sources for literature review. This planning is from week 1 until week 4.

Then, the designing stage start at studying the Morphological chart, verify the product design a concept of rocket. At this stage, the concepts is sketched and designed by using the SolidWorks software. This planning is running in week 3 to week 6.

For the week 5 until week 8, the materials selection is done and the fabrication process is started. All the materials are shaped and join together by using welding and fastening process, and the measurements are verified before running the cutting process.

The pre-presentation and first draft submission is done on week 7.After semester break, the fabrication process on the project including with the finishing process are continue until the week 13, project report that start from week 3 is continued until week 13 and lastly the final presentation on week 14.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Literature Review of this project is totally highlated the research about rocket engine.All information will be explain in this chapter.

2.2 ROCKET ENGINE

2.2.1 Rocket Engine Synopsis

A **rocket engine**, or simply "rocket," is a jet engine that uses only propellant mass for forming its high speed propulsive jet. Rocket engines are reaction engines and obtain thrust in accordance with Newton's third laws. Since they need no external material to form their jet, rocket engines can be used for spacecraft propulsion as well as terrestrial uses, such as missiles. Most rocket engines are internal combustion engines, although non combusting forms also exist.Rocket engines as a group, have the highest exhaust velocities, are by far the lightest, and are the most energy efficient (at least at very high speed) of all types of jet engines. However, for the thrust they give, due to the high exhaust velocity and relatively low specific energy of rocket propellant, they consume propellant very rapidly.The important thing went making a rocket is a shape and dimension of nozzle.The large bell or cone shaped expansion nozzle gives a rocket engine its characteristic shape.In rockets the hot gas produced in the combustion chamber is permitted to escape from the combustion chamber through an opening (the "throat"), within a high expansion-ratio 'de Laval nozzle'.Provided sufficient pressure is provided to the nozzle *chokes* and a supersonic jet is formed, dramatically accelerating the gas, converting most of the thermal energy into kinetic energy.The exhaust speeds vary, depending on the expansion ratio

The nozzle is designed to give, but exhaust speeds as high as ten times the speed of sound of sea level air are not uncommon.Rocket thrust is caused by pressures acting in the combustion chamber and nozzle. From Newtons third law, equal and opposite pressures act on the exhaust, and this accelerates it to high speeds.About half of the rocket engine's thrust comes from the unbalanced pressures inside the combustion chamber and the rest comes from the pressures acting against the inside of the nozzle (see diagram). As the gas expands (adiabatically) the pressure against the nozzle's walls forces the rocket engine in one direction while accelerating the gas in the other.

2.2.2 Type Of Rocket Engine

There are several different type of rocket. There are solid rocket, liquid rocket, hybrid rocket and thermal rocket. Every type of this rocket have their different operational than others rocket.

i) Hybrid Rocket

A **hybrid rocket** is a rocket with a rocket engine which uses propellants in two different states of matter - one solid and the other either gas or liquid. The Hybrid rocket concept can be traced back at least 75 years. Hybrid rockets exhibit advantages over both liquid rockets and solid rockets especially in terms of simplicity, safety, and cost.[2] Because it is nearly impossible for the fuel and oxidizer to be mixed intimately (being different states of matter), hybrid rockets tend to fail more benignly than liquids or solids. Like liquid rockets and unlike solid rockets they can be shut down easily and are simply throttle-able. The theoretical specific impulse(I_{sp}) performance of hybrids is generally higher than solids and roughly equivalent to hydrocarbon-based liquids. I_{sp} as high as 400s has been measured in a hybrid rocket using metalized fuels.[3] Hybrid systems are slightly more complex than solids, but the significant hazards of manufacturing, shipping and handling solids offset the system simplicity advantages.

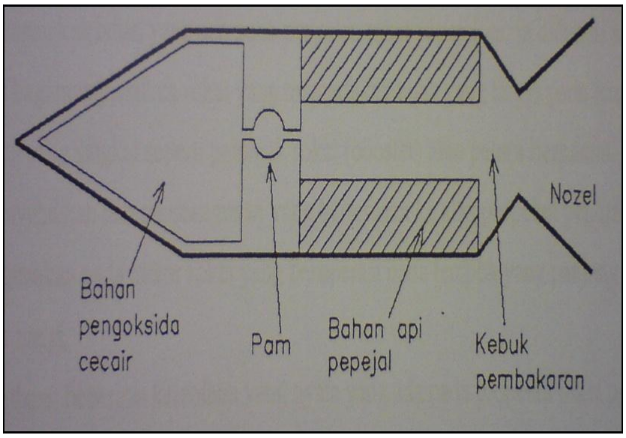

Figure 2.1:Hybrid Rocket

SOURCE:Ciri-Ciri Propelan Roket Pepejal Berasaskan Kalium By Rizalman Mamat

ii) Thermal rocket

a) Nuclear Thermal Rocket

In a nuclear thermal rocket a working fluid, usually liquid hydrogen, is heated to a high temperature in a nuclear reactor, and then expands through a rocket nozzle to create thrust. The nuclear reactor's energy replaces the chemical energy of the reactive chemicals in a chemical rocket engine. Due to the higher energy density of the nuclear fuel compared to chemical fuels, about 10^7 times, the resulting propellant efficiency (effective exhaust velocity) of the engine is at least twice as good as chemical engines. The overall gross lift-off mass of a nuclear rocket is about half that of a chemical rocket, and hence when used as an upper stage it roughly doubles or triples the payload carried to orbit.

A nuclear engine was considered for some time as a replacement for the J-2 used on the S-II and S-IVB stages on the Saturn V and Saturn I rockets. Originally "drop-in" replacements were considered for higher performance, but a larger replacement for the S-IVB stage was later studied for missions to Mars and other high-load profiles, known as the S-N. Nuclear thermal space "tugs" were planned as part of the Space Transportation System to take payloads from a propellant depot in Low Earth Orbit to higher orbits, the Moon, and other planets. Robert Bussard proposed the Single-Stage-To-Orbit "Aspen" vehicle using a nuclear thermal rocket for propulsion and liquid hydrogen propellant for partial shielding against neutron back scattering in the lower atmosphere. The Soviets studied nuclear engines for their own moon rockets, notably upper stages of the N-1, although they never entered an extensive testing program like the one the U.S. conducted throughout the 1960s at the Nevada Test Site. Despite many successful firings, American nuclear rockets did not fly before the space race ended.

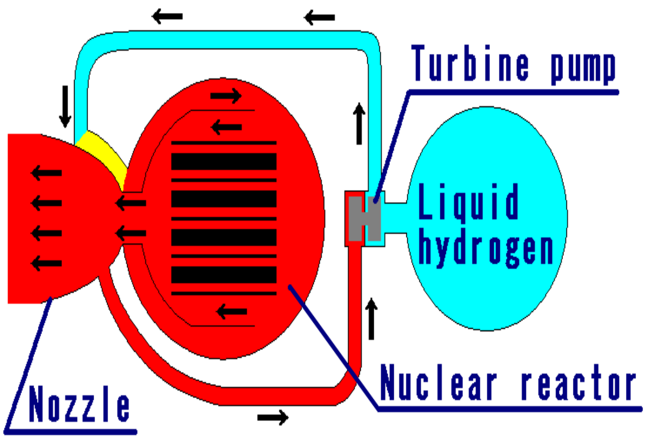

Figure 2.2:Nuclear Thermal Rocket

Source**:**Wikimedia.org

b) Solar Thermal Rocket

Solar thermal propulsion is a form of spacecraft propulsion that makes use of solar power to directly heat reaction mass, and therefore does not require an electrical generator as most other forms of solar-powered propulsion do. A solar thermal rocket only has to carry the means of capturing solar energy, such as concentrators and mirrors. The heated propellant is fed through a conventional rocket nozzle to produce thrust. The engine thrust is directly related to the surface area of the solar collector and to the local intensity of the solar radiation.

In the shorter term, solar thermal propulsion has been proposed as a good candidate for use in reusable inter-orbital tugs, as it is a high-efficiency low-thrust system that can be refuelled with relative ease.

There are two basic solar thermal propulsion concepts, differing primarily in the method by which they use solar power to heat the propellant.

- Indirect solar heating involves pumping the propellant through passages in a heat exchanger that is heated by solar radiation. The windowless heat exchanger cavity concept is a design taking this radiation absorption approach.
- Direct solar heating involves exposing the propellant directly to solar radiation. The rotating bed concept is one of the preferred concepts for direct solar radiation absorption; it offers higher specific impulse than other direct heating designs by using a retained seed (tantalum carbide or hafnium carbide) approach. The propellant flows through the porous walls of a rotating cylinder, picking up heat from the seeds, which are retained on the walls by the rotation. The carbides are stable at high temperatures and have excellent heat transfer properties.

iii) Liquid Rocket

A liquid-propellant rocket or a liquid rocket is a rocket with an engine that uses propellants in liquid form. Liquids are desirable because their reasonably high density allows the volume of the propellant tanks to be relatively low, and it is possible to use lightweight pumps to pump the propellant from the tanks into the engines, which means that the propellants can be kept under low pressure. This permits the use of low mass propellant tanks, permitting a high mass ratio for the rocket.Liquid rockets have been built as monopropellant rockets using a single type of propellant, bipropellant rockets using two types of propellant, or more exotic tripropellant rockets using three types of propellant. Bipropellant liquid rockets generally use one liquid fuel and one liquid oxidizer, such as liquid hydrogen or a hydrocarbon fuel such as RP-1, and liquid oxygen. This example also shows that liquid-propellant rockets sometimes use cryogenic rocket engines, where fuel or oxidizer are gases liquefied at very low temperatures.Liquid propellants are also sometimes used in hybrid rockets, in which they are combined with a solid or gaseous propellant.

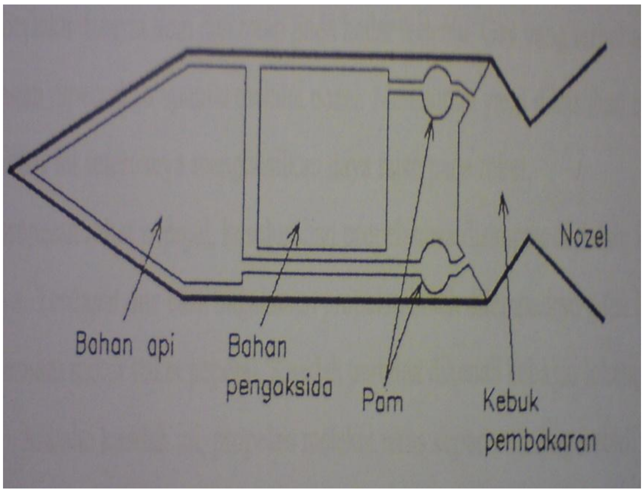

Figure 2.3: Liquid Rocket

SOURCE: Ciri-Ciri Propelan Roket Pepejal Berasaskan Kalium By Rizalman Mamat

iv) Solid Rocket

A **solid rocket** or a **solid-fuel rocket** is a rocket with a motor that uses solid propellants (fuel/oxidizer). The earliest rockets were solid-fuel rockets powered by gunpowder; they were used by the Indians, Chinese, Mongols and Arabs, in warfare as early as the 13th century.

All rockets used some form of solid or powdered propellant up until the 20th century, when liquid rockets and hybrid rockets offered more efficient and controllable alternatives. Solid rockets are still used today in model rockets and on larger applications for their simplicity and reliability.

Since solid-fuel rockets can remain in storage for long periods, and then reliably launch on short notice, they have been frequently used in military applications such as missiles. Solid-fuel rockets are unusual as primary propulsion in modern space exploration, but are commonly used as booster rockets.

A simple solid rocket motor consists of a casing, nozzle, grain (propellant charge), and igniter.

The grain behaves like a solid mass, burning in a predictable fashion and producing exhaust gases. The nozzle dimensions are calculated to maintain a design chamber pressure, while producing thrust from the exhaust gases.

Once ignited, a simple solid rocket motor cannot be shut off, because it contains all the ingredients necessary for combustion within the chamber in which they are burned. More advanced solid rocket motors can not only be throttled but also be extinguished and then re-ignited by controlling the nozzle geometry or through the use of vent ports. Also, pulsed rocket motors that burn in segments and that can be ignited upon command are available.

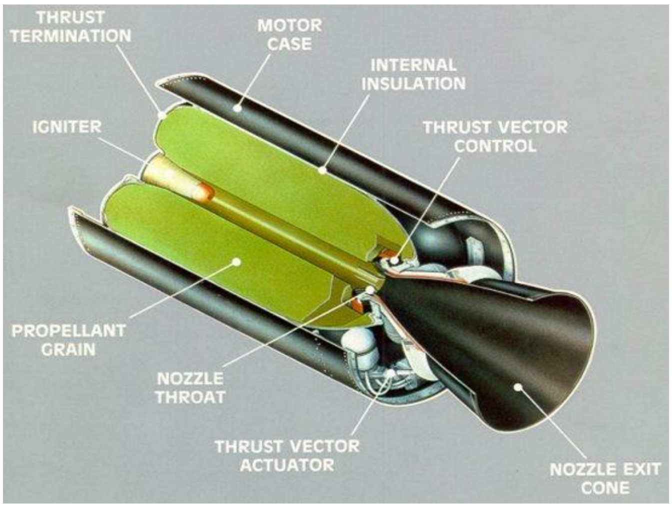

Figure 2.4: Solid Rocket

Source:purdue.edu

2.3 WHAT IS SOLID ROCKET?

Solid rocket engine or motor rocket engine is the type of rocket that use on air to air and air to ground missiles on rocket besides that it also use as a booster for satellite launchers. In a solid rocket, the fuel and oxidizer are mixed together into a solid propellant which is packed into a solid cylinder. A hole through the cylinder serves as a combustion chamber. When the mixture is ignited, combustion takes place on the surface of the propellant. A flame front is generated which burns into the mixture. The combustion produces great amounts of exhaust gas at high temperature and pressure. The amount of exhaust gas that is produced depends on the area of the flame front and engine designers use a variety of hole shapes to control the change in thrust for a particular engine. The hot exhaust gas is passed through a nozzle which accelerates the flow. Thrust is then produced according to Newton's third law of motion.

The amount of thrust produced by the rocket depends on the design of the nozzle. The smallest cross-sectional area of the nozzle is called the throat of the nozzle. The hot exhaust flow is choked at the throat, which means that the Mach number is equal to 1.0 in the throat and the mass flow rate **m dot** is determined by the throat area. The area ratio from the throat to the exit **Ae** sets the exit velocity **Ve** and the exit pressure **pe**. You can explore the design and operation of a rocket nozzle with our interactive nozzle simulator program which runs on your browser.

The exit pressure is only equal to free stream pressure at some design condition. We must, therefore, use the longer version of the generalized thrust equation to describe the thrust of the system. If the free stream pressure is given by **p0**, the thrust **F** equation becomes: